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(54) FRICTION-SURFACE SHEET

(71) We, MINNESOTA MINING AND MANUFACTURING COMPANY, a corporation organized and existing under the laws of the state of Delaware, United States of America, of 3M Center, Saint Paul, Minnesota, 55101, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to friction-surface sheet materials and to their preparation.

Typically, present friction-surface or non-skid sheet materials are made by adhering granules to resin-impregnated fabric backing or plastic film by means of adhesive which is usually pigmented and overcoats the granules to provide a pleasing surface, both esthetically and underfoot. While such products have seen considerable commercial success, they have certain inadequacies which the present invention eliminates.

Since these prior art sheet materials are all formed by depositing granules on a backing sheet and overcoating the granules with adhesive, the resultant product is inherently subject to the formation of air pockets among the adhesive covered granules. Such air pockets will rupture, providing sites for bacteria to accumulate and flourish, staining the sheet and creating a health hazard. Additionally, while seemingly simple to produce, the friction-surface sheet material containing granules requires extremely careful coating conditions and particle size control, or else a non-uniform surface product will be produced. Furthermore, while these prior art granule-containing sheets at first appear attractive, they may lose their attractive uniform surface as their upper surface of pigmented adhesive is abraded away during use, exposing the granules contained within, which are usually not the same colour.

While, at first appearance, an easy solution to the inadequacies discussed above would seem to be to simply emboss a thermoplastic sheet to impart a friction surface, attempts to produce such a sheet have yielded inferior products. Embossing an unsupported layer of a tough scuff-resistant thermoplastic resin, however, results in a product which lacks dimensional stability and easily distorts in use. Laminating a layer of embossable thermoplastic resin to a dimensionally stable backing such as heat-set, biaxially oriented polyethylene terephthalate is difficult because of the latter's non-adherent surface, which virtually defies permanent adhesion thereto by resins having the desired properties for the embossed layer. Products have been made by interposing a normally tacky and pressure-sensitive adhesive layer between the backing layer and the embossed upper layer, but these are expensive to make and eventually delaminate in use or upon subsequent removal from a substrate after use, leaving a difficult to remove residue.

Despite the fact that friction-surface sheets have been known for more than a decade, no adequate solution has been provided for the inadequacies set forth above.

According to the present invention there is provided a friction-surface sheet material comprising the following sequential layers:

a) a layer of embossed, flexible ethylenic copolymer material having a shore A durometer hardness value in the range 60 to 95, the layer having a tensile strength of at least 700 psi, an elongation at break of at least 100% and a surface having a dynamic coefficient of friction greater than 0.45 on dry leather

optionally b) a polymer prime layer,

c) a heat-set, biaxially oriented, poly-

ethylene terephthalate backing layer having a thickness in the range 1 to 5 mils

optionally d) a polymer prime layer,

e) a tacky and pressure-sensitive adhesive layer having a thickness in the range 2 to 10 mils, and

optionally f) a release liner.

Also according to the invention there is provided a process for the preparation of a friction surface sheet material comprising

1) coating one major surface of a heat-set biaxially oriented, polyethylene terephthalate backing film having a thickness in the range 1 to 5 mils with: optionally

(i) a polymer prime layer and

(ii) an ethylenic polymer material to form an embossable layer and embossing the layer with a surface pattern, the layer having a shore A durometer hardness value in the range 60 to 95, a tensile strength of at least 700 psi, an elongation at break of at least 100% and a surface having a dynamic coefficient of friction greater than 0.45 on dry leather, and

2) coating the other major surface of the polyethylene terephthalate backing film with: optionally

(iii) a polymer prime layer and

(iv) a tacky and pressure-sensitive adhesive to form a layer having a thickness in the range 2 to 10 mils.

The present invention provides a friction-surface sheet which can be rapidly and economically produced in large quantities, without the use of granules and without the special coating techniques associated therewith. The sheet has the desired frictional characteristic, dimensional stability, abrasion resistance moisture resistance, tear resistance, and crack resistance for the use described herein, combined with adequate elongation, stretchability, and deformability and may provide a long-lasting, effective, frictional surface sheet under virtually all climatic conditions.

The friction-surface sheet can be made by coating an ultra-violet light transmissive, coherent layer of film-forming thermoplastic polymer onto one surface the polyethylene terephthalate layer, irradiating the layer interface with ultra-violet light for a time and at an intensity sufficient to creat an adherent bond between the layers, coating molten ethylenic copolymer on top of the polymer to provide an embossable layer, and embossing the copolymer layer to impart the desired textured surface. Other ways of obtaining this laminated structure will also be disclosed. Tacky and pressure-sensitive adhesive is applied to the other surface of the sheet thus described to facilitate mounting thereof to any of a variety of substrates.

Understanding of the invention will be facilitated by referring to the accompanying drawing, wherein:

Figure 1 is a schematic representation of the preferred method of preparing the friction-surface sheet of the invention;

Figure 2 is a cross sectional view taken at line 2—2 of Figure 1;

Figure 3 is a cross sectional view taken at line 3—3 of Figure 1;

Figure 4 is a cross sectional view taken at line 4—4 of Figure 1;

Figure 5 is a cross sectional view taken at line 5—5 of Figure 1; and

Figure 6 is a cross sectional view showing the friction-surface sheet of the invention and is taken at line 6—6 of Figure 1.

In accordance with the invention and as depicted in Figures 2 to 6, flat, biaxially oriented, heat-set polyethylene terephthalate film 11 of substantially uniform thickness is adherently bonded to thermoplastic polymer layer 13 which is adherently bonded to embossed layer 18 formed of a tough, flexible, scuff-resistant, weather-resistant, thermoplastic ethylenic copolymer. The opposite surface of polyethylene terephthalate film 11 is adherently bonded to normally tacky and pressure-sensitive adhesive layer 38 which may be protected prior to use by a suitable release liner 39. A prime coating 37 of rubber may be desired when rubber-base adhesive compositions are used as the pressure-sensitive adhesive layer.

As shown in Figure 1, the friction-surface sheet material is prepared by first coating biaxially oriented heat-set polyethylene terephthalate film 11 obtained from supply roll 10. An ultra-violet light transmissive, coherent layer of thermoplastic polymer primer is extruded as a molten sheet 13a from extruder 12 onto the upper surface of film 11 to provide coated film 14. Coated film 14 is irradiated by ultra-violet light source 15 through the coating at an intensity and for a time sufficient to cause adherent bonding between the coating and the polyethylene terephthalate film to produce primed laminate 16. Molten copolymer as sheet 18a is extruded from extruder 17 onto the primed surface as the freshly coated composite film and is simultaneously passed between embossing roll 20 and backup roll 19 to produce embossed film 21. After hardening, film 21 is passed under tension over decurling edge 23 between idler rolls 22 and 25 to make the embossed surface convex. Decurled laminate 24 is then primed on its lower surface by roll coating a rubber/solvent priming solution 28 contained in vessel 29 with coater roll 27 which operates in opposition to backup roll 26. Rubber-coated composite film 30 is then dried of solvent at

drying station 31 by use of either a circulating air source, oven, hot can dryer, or a combination thereof, providing rubber coated laminate 32. Laminate 32 is exposed to a second ultra-violet light source 33 through the rubber coat and irradiated therewith to cause a permanent adherent bond between the rubber layer and the polyethylene terephthalate film surface, providing composite film 34. Pressure-sensitive adhesive, as a self-supporting film (carried on a suitable release liner to prevent blocking) is then dispensed from roll 35 so that its exposed adhesive surface contacts the rubber-primed surface and this composite is passed between nip rolls 40 and 41 to consolidate the layers into an integral sheet which is wound as roll 36 for storage.

Figures 2 to 6 show the various stages of formation of the laminate formed by the process of Figure 1. It is, of course, understood that the process may also be accomplished in individual steps wherein, after each process step which produces a hardenable intermediate, the intermediate may be stored, and thereafter completed. For example, it may be desired to do some of the process steps at one location and others at another location.

Although the presently preferred embodiment specifies rubber-base tacky and pressure-sensitive adhesive applied over an initial prime coat, that is not the only type tacky adhesive which can be used. Other tacky and pressure-sensitive adhesives useful in the present invention will be exemplified and illustrated hereinafter.

Other ways of forming the friction-surface sheet material of the invention are possible and within the scope of the invention. For example, the polyethylene terephthalate and the copolymer layer may be coextruded to provide an integral composite film which can subsequently be biaxially oriented and heat-set. Additional copolymer is then coated on the composite's copolymer surface by melt fusion to provide the desired thickness for embossing as described above. Thereafter, adhesive is applied to the unembossed lower surface by the method disclosed above or by conventional adhesive coating techniques.

Coextrusion is a well known process wherein layers of thermoplastic materials are brought into contact while they are still molten. Formation and adhering of the layers takes place inside or immediately outside the extruding die, forming a composite film. The composite film is thereafter endowed with improved physical properties by biaxial orientation and heat-setting. Biaxial orientation, as is also well known, involves stretching the film in two directions normal to each other, generally in the machine direction and at right angles thereto. In a typical operation, the freshly formed molten composite film is fed onto a cooling drum to produce a quenched amorphous film, which is briefly heated and stretched in the machine direction, and then conducted through a tenter frame where it is stretched transversely with moderate heating. Machine direction stretching may be accomplished by passing between two sets of nip rolls the second set rotating at a high speed than the first. Stretching typically increases the film area by a factor of at least six, the stretching usually being equal in each direction.

Heat-setting, or heat stabilization, of the stretched composite film is accomplished by restraining the film at its stretched dimension and heating briefly, then quenching. Such heating is typically in the range of 175°C to 240°C.

The backing sheet of the friction-surface sheet material of the invention is, as previously discussed, formed of biaxially oriented, heat-set polyethylene terephthalate. Such a material is well known and commercially available under the trade designations "Mylar" and "Scotch Par". This film is noted for its toughness, dimensional stability and inertness under a wide variety of conditions. For the invention, it has been found useful to use such film at thicknesses of 1 to 5 mils (25 to 125 microns). Film widths will vary depending upon the processing equipment, typically between 24 and 60 inches (50 to 150 cm).

The priming polymer coated on the upper surface of the polyethylene terephthalate film is a film-forming thermoplastic capable of being formed into coherent, film which is transmissive to ultraviolet light, capable of forming an adherent bond with the polyethylene terephthalate film under the influence of ultra-violet irradiation, and capable of forming an adherent bond with the upper copolymer layer discussed hereinafter by melt fusion. The priming polymer layer should be thin enough to permit irradiation through its thickness, not contain ultra-violet light absorbing fillers, and be sufficiently coherent to resist cohesive failure when used as herein disclosed. Typically, the prime layer will be 0.5 to 3 mils (10—75 microns) thick. Suitable polymeric materials found useful for the prime layer include polymers of ethylene such as polyethylene and ethylene ethyl acrylate and ethylene vinyl acetate copolymers.

The upper, embossed layer is of an ethylene copolymer which is tough, scuff-resistant, moisture-resistant, weather-resistant, and flexible. This copolymer should also have a hardness value within the range of about 60 to 95 shore A durometer (preferferably (70 to 90), have a dynamic coefficient of friction with respect to dry leather greater than 0.45 when embossed have a tensile

strength of at least 700 psi (50 kg per sq cm), and have a elongation of at least 100%.

The embossed layer is also resistant to permanent deformation at temperatures below 90°C in that there should be no perment dimensional modification in the layer when it is subjected to a force such as the pressure imposed by the heel of a shoe being worn by a pedestrian. That is, the surface of the layer may yield somewhat but such yielding will not be permanent.

The dynamic coefficient of friction of the embossed layer is determined by utilizing the following procedure. Two pieces of vegetable—tanned cattle-hide sole leather, 1/4 inch by 1/2 inch by 10 inches (0.6 cm by 1.3 cm by 25 cm) are bonded to a 1 inch by 5 inch by 10.5 inch (2.5 cm by 13 cm by 28 cm) block of maple. Weights are added to provide a total weight of 20 pounds (9 kg). The strips extend lengthwise symmetrically and about 4 inches (10 cm) apart on the 5″ by 10.5″ (13 cm by 28 cm) face of the block, with the flesh surfaces of the leather exposed. The exposed leather surfaces are lightly sanded before run with 2/0 garnet paper and wiped clean of sanded particles with a cloth. The test block is placed on the leather strips on one end of an 18 inch (46 cm) long by 6 inch (15 cm) wide test panel adhered to a level surface and the load required to pull the block 7 inches (18 cm) across the panel at a speed of 20 inches (50 cm) per minute is recorded. Three runs on each test speciman are made and averaged. The dynamic coefficient of friction is the average load divided by the weight of the block.

Embossed polymer surfaces having a dynamic coefficient of friction less than 0.45 on dry leather are deemed too slippery for use as nonslip or friction-surface sheet material.

Copolymers suitable for use in the invention and having the properties described above include ethylenic copolymers (and terpolymers) such as prepared from ethylene and olefinically unsaturated monomers such as alkyl acrylates, propylene, vinyl acetate, butadiene, hexadienes, and combinations thereof. Commercially available forms of such copolymers include ethylene ethyl acrylate copolymers such as that sold under the trade designations "Bakelite DPD 6169" and "Bakelite DPD 6182", ethylene vinyl acetate such as that sold under the trade designations "Bakelite DQD 1868", "Bakelite DQD 6182", "Elvax 260" and "Ultrathene UE 645X", "Ultrathene 637", "Ultrathene 630-81" and "Ultrathene 631", and ethylene propylene diene terpolymers such as those sold under the trade designations "Nordel 1500", "TPR 1900" and "TPR 2000".

The copolymer comprising the upper surface of the friction-surface sheet of the invention may incorporate fillers or pigments to impart color or improve the physical properties in this layer. Such fillers, which include carbon black, clays, magnesium oxide, reclaimed rubber, fine scrap rubber particles, process oils, and other materials known in the art, can be used up to 70% by weight of the total weight of this layer. The fillers may be added to the copolymer prior to extruding it onto the backing film, by milling, mixing such as in a "Banbury" machine, and in other ways known in the art.

The copolymer layer will typically have an average thickness of 10 to 60 mils (0.25 to 1.5 mm), and when embossed, will typically have a thickness of 3 to 25 mils (0.08 to 0.6 mm) or more at its thinnest portion (at the valleys).

The rubber prime coat, for promoting adhesion between a rubber base pressure-sensitive adhesive and the lower surface of the polyethylene terephthalate film, may be applied as a solution of natural rubber in an organic solvent such as heptane or trichloroethylene, typically 2 to 3% by weight rubber. This prime layer, which will be typically less than 0.5 mil (10 microns) thick, can be eliminated and the rubber-base adhesive merely coated directly by conventional techniques upon the polyethylene terephthalate backing film surface, but priming provides a bond of superior strength between the backing film and the rubber base adhesive and, therefore, is preferred.

The rubber base adhesive most preferred for use on the friction-surface sheet material of the invention is a tacky, pressure-sensitive abrasion-resistant, bakelized crude rubber adhesive. This type of adhesive is disclosed in U.S. Patent Nos. 2,269,712, 2,410,079, and 2,177,627. Other normally tacky and pressure-sensitive adhesive which can be used include the tackified AB block copolymer adhesives disclosed in U.S. Patent No. 3,787,531 and acrylate adhesive disclosed in U.S. Patent Re. No. 24,906. The pressure-sensitive adhesive layer is preferably 2 to 10 mils (50—250 microns) thick.

The roll used to emboss the copolymer layer has a surface which is the counterpart of that desired for the friction-surface sheet material of the invention. The roll surface may be generated by engraving, rough sand-blasting, or other ways which involve importing an embossed surface to a smooth cylindrical metal roll. The embossed surface may have a uniform pattern, include indicia, or may be of a random nature, as long as it embosses the desired surface into the sheet material.

One method of preparing an embossing roll suitable for use in the invention is by shaping an original which may be a prior art friction-surface sheet into a tubular form

(with the textured surface forming the inner surface of the tube), supporting the tube in a temporary rigid tubular structure, sensitizing the textured surface so that metal can be electrically deposited thereon, and electrically depositing metal to build up a rigid structure suitable for use as an embossing roll. The temporary rigid structure and the original are then removed to reveal the embossing roll which can be supported for rotation. This method of producing an embossing roll is disclosed in U.S. Patent No. 2,749,294.

The invention is further illustrated by reference to the following examples, in which all parts and percentages are by weight unless otherwise noted.

EXAMPLE 1

A 26 inch (66 cm) wide, 3 mil (75 micron) thick continuous sheet of biaxially oriented, heat-set polyethylene terephthalate (commercially available under the trade designation "Scotch Par" from the 3M Company) was primed by extruding a 1 mil (25 micron) thick layer of ethylene ethyl acrylate copolymer having a melt index of 6 (commercially available under the trade designation "Bakelite DFDA 6169" from the Union Carbide Company) thereon as a uniform layer. The extruder had barrel temperatures of 150°C, 200°C, 260°C, 280°C and 290°C, respectively, gate temperature of 290°C, die neck temperature of 290°C, die temperature of 290°C, and end plate temperature of 290°C. The coating was permitted to cool and the coated polyethylene terephthalate film was passed, film side in, around a 6 ft (1.8 m) diameter hot can (130°C surface temperature) approximately one inch (2.5 cm) from 120 equally spaced tubular ultra-violet lights (type G 64T6) arranged in 270° wrapped within a shroud around the hot can to provide an irradiation residence time of about 0.2 minute, with the coated side facing the ultra-violet lights. The polyethylene terephthalate film was then coated using a second extruder on the primed surface with a blend of (1) 94.5 parts ethylene ethyl acrylate copolymer consisting of 18% ethyl acrylate and 82% ethylene (sold under the trade designation "Bakelite DFD 6169" by the Union Carbide Co.) (2) 5 parts of a predispersed mixture of one part titanium dioxide in one part low density polyethylene available under the trade designation "PMS 08500" (3) 0.2 part of a bacteriostat (sold under the trade designation "Vancide 89") and (4) 0.25 parts of an ultraviolet light absorber ("Cyasorb UV531") at an average thickness of 15 mils (0.4 mm). The second extruder had barrel temperatures of 120°C, 140°C, 160°C and 165°C, respectively, a neck temperature of 145°C, and a die temperature of 155 to 170°C. The coated film was then passed between an 8 inch (20 cm) diameter embossing roll and an 8 inch (20 cm) diameter rubber backup roll having a Shore A hardness value of 60—80 with the copolymer surface exposed to the embossing roll, providing the ethylene ethyl acrylate copolymer layer with an embossed surface. Since this film had a tendency to curl away from the polyethylene terephthalate side, it was decurled by passing between idler rolls over a decurling tension bar while under tension of about 400 pounds (180 kg) with the polyethylene terephthalate surface against the bar. The decurled laminate was roll coated on the remaining polyethylene terephthalate surface with a 2.8% natural rubber/heptane solution having a viscosity of about 150 to 200 cP. A very thin rubber coating [less than 0.5 mil (13 microns) thick] resulted, once the coating had been dried by passing it over a 68°C hot can. The rubber coating was irradiated from a distance of 1 inch (2.5 cm) with an ultra-violet light source consisting of 18 lamps arranged 3/4 inch (2 cm) apart in a 2 1/2 feet (76 cm) linear pattern with a residence time of 0.1 minute. Thereafter, a self-supporting, 4 mil (0.1 mm) thick, bakelized pressure-sensitive tacky adhesive composition prepared by mixing of equal parts of "Part A" and "Part B" described in the table below and sufficient heptane/ethanol (97/3) solution to make the viscosity 5000 cps, coating the mixture on a silicone oil coated paper release liner, and evaporating the solvent. The resultant adhesive layer was laminated to the rubber-primed side of the polyethylene terephthalate film by passing the superimposed layers between nip rolls consisting of an 11.5 inch (30 cm) diameter metal roll and 9.5 inch (25 cm) diameter rubber roll having a Shore A hardness of approximately 60 to 80 at a roll to roll pressure of 15 pounds (0.7 kg) per inch of width of contact.

Rubber Base Pressure-Sensitive Adhesive
Part A

Ingredient	Parts by Weight
Crude rubber	100.0
Zinc oxide	66.00
Anhydrous lanolin	6.75
Natural pine rosin ("Nelio N Gum")	6.75
Oil-soluble heat-reactive para-substituted phenol aldehyde tackifier resin ("Bakelite CKR-1634")	4.38
Heptane	266
Denatured ethyl alcohol	25

Part B

Ingredient	Parts by Weight
Pale crepe rubber	100
Polyterpene tackifier ("Piccolyte-S-115" resin)	47.2
Zinc resinate having a melting point of 165°C and acid number of zero ("Zirex Resin")	9.42
Tricresyl phosphate	4.69
2,5-di-tert-amylhydroquinone antioxidant ("Santovar A")	2.03
Oil-soluble heat-reactive para-substituted phenol aldehyde tackifier resin ("Bakelite CKR-1634")	5.69
Titanium dioxide	3.86
Carbon black	0.08
Cyclohexylamine	0.02
Denatured ethyl alcohol	18.82
Toluene	18.82
Heptane	451

("Piccolyte-S-115", "Zirex Resin", "Santovar A" and "Bakelite CKR-1634" are Registered Trade Marks).

The resultant friction-surface sheet (less the release liner), which had an embossed surface, overall thickness of 30 mils (0.8 mm) and an average thickness of 23 mils (0.6 mm), provided an excellent underfoot friction-surface when cut to size and applied to stairs, bath tubs and showers.

EXAMPLE 2

An embossed layer adherently bonded to polyethylene terephthalate backing film was prepared according to Example 1 and to such a structure was bonded 5 mils (0.13 mm) of a polystyrene-polyisoprene AB block copolymer without a primer. The A block was polystyrene having a molecular weight of 45,000 and the B block was polyisoprene having a molecular weight of 105,000. The adhesive was of the following ingredients:

AB Block Copolymer Adhesive

Ingredients	Parts
AB block copolymer	100
Petroleum resin tackifier ("Wingtack 95")	25
Antioxidant ("Inganox 1076")	2
Titanium dioxide	0.5

("Wingtack 95" and "Irganox 1076" are registered trade-marks).

EXAMPLE 3

A friction-surface sheet product was formed by adhering to the polyethylene terephthalate surface of embossed upper layer/backing film of Example 1 a pressure-sensitive adhesive containing the AB block copolymer described in Example 2 and multi-block copolymer styrene-butadiene-styrene block copolymer) sold under the trade designation "Kraton 1108". The adhesive contained the following ingredients:

AB/Multi-Block Copolymer Adhesive

Ingredients	Parts
Multi-bluock copolymer ("Kraton 1108")	23
AB block copolymer	77
Petroleum resin tackifier ("Wingtack 95")	35
Antioxidant ("Irganox 1076")	2
Titanium dioxide	0.5

Example 4

A friction-surface sheet material was prepared as in Example 2 except that the adhesive used was of a multi-block copolymer of the folowing ingredients:

Multi-Block Copolymer Adhesive

Ingredients	Parts
Multi-block copolymer ("Kraton 1108")	100
Polyterpene tackifier resin ("Piccolyte S-115")	100
Aliphatic process oil ("Sun Par 2280")	10

Example 5

A friction-surface sheet material was prepared as in Example 2 except that the adhesive used was a normally tacky and pressure-sensitive 10:90 acrylic acid:isooctyl acrylate copolymer such as described in Example 7 of United States Reissue Patent No. 24,906.

Example 6

A friction-surface sheet material was prepared according to Example 1 except the ethylene ethyl acrylate prime coating was replaced by an ethylene vinyl acetate copolymer (sold under the trade designation "Bakelite DQDA 3737" by the Union Carbide Co.). For this material the extruder had barrel temperatures of 110°C, 130°C and 150°C a neck temperature of 150°C, a body temperature of 150°C and gate temperatures of 150°C.

Example 7

The polyethylene terephthalate backing film was prepared by coextrusion wtih thermoplastic polyester ("Hytrel 4055") to form a 3 mil (0.08 mm) composite film having a 0.75 mil (0.02 mm) polyethylene terephthalate layer, after orientation and heat-setting. The polyester ("Hytrel 4055") extruder had barrel temperatures about 140°C, 185°C, 190°C and 225°C, and a die temperature about 225°C. The composite

sheet was oriented at 80°C by stretching 2.8 times in the machine direction and 2.8 times in the transverse direction, and heat-set by heating at 190°C for 12 seconds.

The polyester ("Hytrel 4055") surface was coated (without additional primer) with ethylene ethyl acrylate copolymer ("Bakelite DFDA 6169"), embossed and the other surface of the polyethylene terephthalate film bonded to an adhesive layer as described in Example 1, without a primer.

Example 8

A 2 mil (0.05 mm) thick polyethylene ("DFD 4947") prime coating was extrusion coated onto 2 mil thick biaxially oriented, heat-set polyethylene terephthalate backing and irradiated according to Example 1. The polyethylene layer surface was overcoated with a mixture of 99 parts ethylene propylene diene terpolymer ("TPR-2000") and 1 part carbon black which was embossed to provide 42 mil (1 mm) thick embossed laminate. The underside of the laminate (the polyethylene terephthalate surface) was primed with natural rubber as described in Example 1 and coated with a pressure-sensitive adhesive consisting of the ingredients designated "Part B" in Example 1.

Example 9

A polyethylene terephthalate film primed on a major surface as described in Example 1 was overcoated with ethylene vinyl acetate copolymer (sold under the trade designation "Ultrathene 645") and embossed as described in Example 1. An adhesive layer was applied as described in Example 1 directly to the other surface of the polyethylene terephthalate film to provide a friction-surface sheet.

Example 10

The embossable copolymer layer used in this Example was a mixture of (1) 20 parts ethylene vinyl acetate copolymer ("Elvax 260") (2) 20 parts powdered polyethylene ("Microethene 715") and (3) 60 parts shredded scrap rubber tyre filler (screened through "Tyler" 12 mesh screen having about 1.41 mm openings). The scrap rubber was a filler which did not undesirably increase the hardness. The copolymer was ground to a powder and mixed with the polyethylene and filler in a 2 stage polyethylene extruder having barrel temperatures of 140°C, 190°C, 200°C and 205°C, a neck temperature of 205°C and a die temperature of 200 to 210°C. The copolymer was coated on a primed polyethylene terephthalate film prepared according to Example 1 and embossed. An adhesive layer was applied as described in Example 1 directly to the other surface of the polyethylene terephthalate film to produce a friction-surface sheet.

The words "Mylar", "Bakelite", "Elvax", "Ultrathene", "Nordel", "TPR", "Cyasorb", "Nelio", "Hytrel" and "Microthene" are all Registered Trade Marks.

WHAT WE CLAIM IS:—

1. A friction-surface sheet material comprising the following sequential layers:

a) a layer of embossed, flexible ethylenic copolymer material having a Shore A durometer hardness value in the range 60 to 95, the layer having a tensile strength of at least 700 psi, an elongation at break of at least 100% and a surface having a dynamic coefficient of friction greater than 0.45 on dry leather,

optionally b) a polymer prime layer,

c) a heat-set, biaxially oriented, polyethylene terephthalate backing layer having at a thickness in the range 1 to 5 mils

optionally d) a polymer prime layer,

e) a tacky and pressure-sensitive adhesive layer having a thickness in the range 2 to 10 mils, and

optionally f) a release liner.

2. A friction-surface sheet matuerial as claimed in Claim 1 in which the ethylenic copolymer is a copolymer or terpolymer formed from ethylene and one or more of alkyl acrylates, propylene, vinyl acetate butadiene and hexadienes.

3. A friction-surface sheet material as claimed in Claim 2 in which the ethylenic copolymer layer is formed of ethylene ethyl acrylate copolymer.

4. A friction-surface sheet material as claimed in Claim 2 in which the ethylenic copolymer layer is formed or ethylene ethyl acrylate copolymer.

5. A friction-surface sheet material as claimed in any preceding claim including a polymer prime layer b).

6. A friction-surface sheet material as claimed in any preceding claim including a polymer prime layer d).

7. A friction-surface sheet material as claimed in Claim 6 in which the polymer prime layer d) is a natural rubber prime layer and the tacky and pressure sensitive adhesive is a rubber base adhesive.

8. A friction-surface sheet material as claimed in any of Claims 1 to 6 in which the tacky and pressure sensitive adhesive is an acrylate adhesive or an AB block copolymer adhesive.

9. A friction-surface sheet material as claimed in Claim 8 in which the AB block copolymer adhesive also contains multiblock copolymer having at least 3 connected polymer blocks.

10. A friction-surface sheet material as claimed in any preceding claim which includes a release liner.

11. A friction-surface sheet material sub-

stantially as herein described with reference to any of the Examples.

12. A friction-surface sheet material substantially as herein described with reference to the accompanying drawings.

13. A process for the preparation of a friction surface sheet material comprising

1) coating one major surface of a heat-set biaxially oriented, polyethylene terephthalate backing film having a thickness in the range 1 to 5 mils with: optionally

(i) a polymer prime layer and

(ii) an ethylenic copolymer material to form an embossable layer and embossing the layer with a surface pattern, the layer having a Shore A durometer hardness value in the range 60 to 95, a tensile strength of at least 700 psi, an elongation at break of at least 100% and a surface having a dynamic coefficient of friction greater than 0.45 on dry leather, and

2) coating the other major surface of the polyethylene terephthalate backing film with: optionally

(iii) a polymer prime layer and

(iv) a tacky and pressure-sensitive adhesive to form a layer having a thickness in the range 2 to 10 mils.

14. A process as claimed in Claim 13 in which the polymer prime layer (i) comprises an ultra-violet light transmissive coating of adherent coherent thermoplastic polymer material and the coating is irradiated with ultra violet light at an intensity and for a time sufficient to produce an adherent bond between the coating and polyethylene terephthalate backing surface prior to the application of the ethylenic copolymer material.

15. A process as claimed in Claim 13 or Claim 14 in which the ethylenic copolymer is a copolymer or terpolymer formed from ethylene and one or more of alkyl acrylates, propylene, vinyl acetate, butadiene and hexadienes.

16. A process as claimed in Claim 15 in which the ethylenic copolymer layer is formed of ethylene ethyl acrylate copolymer.

17. A process as claimed in Claim 15 in which the ethylenic copolymer layer is formed of ethylene ethyl acrylate copolymer.

18. A process as claimed in any of Claims 13 to 17 in which the polymer prime layer (iii) is a natural rubber and the tacky and pressure sensitive adhesive is a rubber base adhesive.

19. A process as claimed in any of Claims 13 to 17 in which the tacky and pressure sensitive adhesive is an acrylate adhesive or an AB block copolymer adhesive.

20. A process as claimed in Claim 19 in which the AB block copolymer adhesive also contains multi-block copolymer having at least 3 connected polymer blocks.

21. A process as claimed in any of Claims 12 to 20 which comprises the additional step to apply a release liner to the tacky and pressure-sensitive adhesive layer.

22. A process for the preparation of a friction-surface sheet material substantally as herein described with reference to any of the Examples.

23. A process for the preparation of a friction surface sheet material substantially as herein described with reference to the accompanying drawings.

24. A friction-surface sheet material when prepared by a process as claimed in any of Claims 12 to 23.

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1481876 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

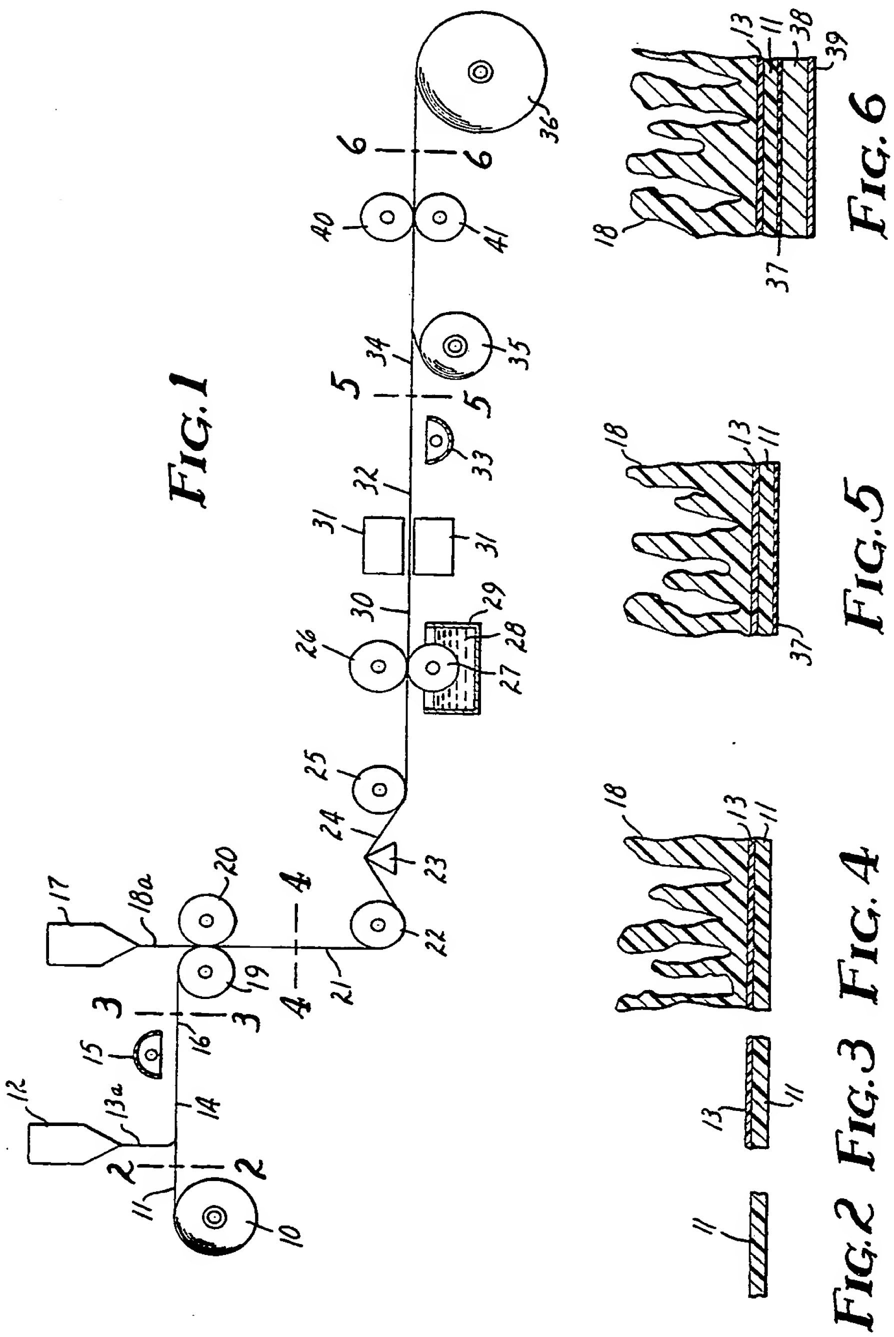

FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6